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under a state that the solder bumps are in contact, heated to a temperature more than the fusing point of the solder, and fused while the ultrasonic bonding head is moved along a circular locus.

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4. A flip chip bonding method for mounting a semiconductor element on a wiring board without using flux comprising steps of:

applying a vacuum to the semiconductor element through an ultrasonic bonding head to fixedly attach the semiconductor element to the ultrasonic bonding head; and

applying a pressure and heat to solder bumps, formed on both or one of a connecting pad of the semiconductor element or a connecting pad of the wiring board for connecting the solder bumps under a state that the solder bumps are in contact, heated to a temperature more than the fusing point of the solder, and fused while the ultrasonic bonding head is moved in a plurality of directions or along a circular locus, wherein no flux is supplied to the solder bumps.

REMARKS

These Amendments and Remarks are being filed in response to the Final Rejection dated August 12, 2002. For the following reasons, this Amendment should be entered, the Application allowed, and the case passed to issue.

This amendment should be entered as it clearly places the application in condition for allowance and no new matter is introduced. New claim 3 is supported by claim 1 and new claim 4 is supported by claim 1 and the specification at page 2, lines 7-8; page 4, lines 20-23; and page 6, lines 7-10.

Claim Rejections Under 35 USC § 103

Claim 1 is rejected under 35 USC § 103(a) as being unpatentable over Taizo (JP 11-097493) in view of Ulmer (U.S. Patent No. 6,138,894). This rejection is traversed, and reconsideration and

withdrawal thereof respectfully requested. The following is a comparison of the claimed invention and the cited prior art.

An aspect of the invention, per claim 1, is a flip chip bonding method for mounting a semiconductor element on a wiring board comprising the steps of applying a vacuum to the semiconductor element through an ultrasonic bonding head to fixedly attach the semiconductor element to the ultrasonic bonding head. Pressure and heat are applied to solder bumps, formed on both or one of a connecting pad of the semiconductor element or a connecting pad of the wiring board for connecting the solder bumps under a state that the solder bumps are in contact, heated to a temperature more than the fusing point of the solder, and fused while the ultrasonic bonding head is moved in a plurality of directions or along a circular locus.

The Examiner asserts that Taizo substantially teaches the claimed process including applying a vacuum to a semiconductor element through an ultrasonic bonding head, applying pressure to gold bumps, and moving the ultrasonic bonding head in a plurality of directions. The Examiner relies on Ulmer to teach applying heat to solder bumps. The Examiner concludes that it would have been obvious to utilize a heater to heat the solder bumps to more than the fusing point in order to ensure the die is bonded to the substrate.

Taizo and Ulmer, whether taken alone or in combination, fail to teach the claimed method. Neither Taizo nor Ulmer teaches or suggests the step of applying heat to the solder bumps to heat the solder bumps to a temperature more than the fusing point of the solder, as required by claim 1.

Claim 1 requires the solder bumps to be heated to a temperature more than the fusing point of the solder. Ulmer, however, teaches away from heating the solder bumps to a temperature more than the fusing point of the solder. Though Ulmer discloses that hot air or gas flow directly on the die/substrate area may be used for melting the solder, Ulmer teaches such methods may not be as

advantageous as heating only the substrate. Ulmer further teaches that it is advantageous to minimize the temperature of the substrate (col. 4, lines 34 - 41). Therefore, one of ordinary skill would not have been motivated to heat the solder bumps to more than the fusing point of solder because one of ordinary skill in the art would seek to minimize the temperature of the substrate.

Furthermore, a prior art reference must be considered in its entirety, i.e., as a **whole**, including portions that would lead away from the claimed invention. Such a teaching away from a claimed invention constitutes potent evidence of non-obviousness. See, for example, *In re Bell*, 991 F.2d 781, 26 USPQ2d 1529 (Fed. Cir. 1993); *In re Hedges*, 783 F.2d 1038, 228 USPQ 685 (Fed. Cir. 1986); *W.L. Gore & Assoc., Inc. v. Garlock, Inc.*, 721 F.2d 1540, 220 USPQ 303 (Fed. Cir. 1983), *cert. denied*, 469 U.S. 851 (1984).

Heating the solder bumps to more than the fusing point of the solder bumps and moving the ultrasonic bonding head in a plurality of directions or along a circular locus causes the oxide films to efficiently migrate to the inside of the solder bumps. Migration of the oxide layer to the inside of the solder bumps allows bonding without the use of flux. This benefit is neither disclosed nor suggested by the prior art.

Claim 2 is rejected under 35 USC § 103(a) as being unpatentable over Taizo in view of Ulmer, and further in view of Kuriyama (U.S. Patent No. 5,315,474). This rejection is traversed, and reconsideration and withdrawal thereof respectfully requested.

The Examiner avers that Kuriyama teaches an inactive or reducing atmosphere during bonding. The Examiner concludes it would have been obvious to use a particular gas in order to prevent oxidation of the bonding surfaces.

Kuriyama, however, does not correct the deficiencies of the Taizo and Ulmer references. Therefore, claim 2 is allowable for at least the same reasons as claim 1. Further, Kuriyama is directed towards connecting fuse wires, not flip chip bonding.

Applicant submits that new claims 3 and 4 are allowable. The prior art does not teach the flip chip bonding method of claim 3, wherein the ultrasonic bonding head is moved along a circular locus. The prior art also does not teach the flip chip bonding method of claim 4, wherein ultrasonic bonding is performed without using flux.

In light of the Amendments and Remarks above, this amendment should be entered, the application allowed, and case passed to issue. If there are any questions regarding this amendment or the application in general, a telephone call to the undersigned would be appreciated to expedite the prosecution of the application.

To the extent necessary, a petition for an extension of time under 37 C.F.R. 1.136 is hereby made. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to Deposit Account 500417 and please credit any excess fees to such deposit account.

Respectfully submitted,

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